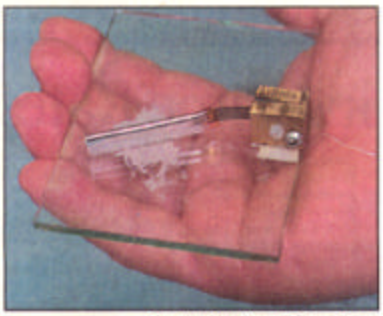
SCIENCE FILE

An exploration of issues and trends affecting science, medicine and the environment



Photos by IRIS SCHNEIDER / Los Angeles Times

Robotic muscle used to run windshield wiper, above. Yosef Bar-Cohen, right, hopes that in 20 years a similar device will be able to win an arm-wrestling contest.

Getting a Grip

■ JPL scientists are developing artificial muscles for a small space rover. Its beginnings are humble, but the technology may someday do everything from helping hearts to providing arm-wrestling competition.

By MICHAEL LUO
TIMES STAFF WRITER

It doesn't look like much: a miniature robotic arm that drops a few inches, spreads its fingers, grasps a pebble and raises it up with excruciating slowness. But some engineers believe it is the beginning of a technological revolution.

That's because the arm moves up and down and its fingers bend and extend by means of so-called electro-active polymers, or artificial muscles.

The polymers are made up of organic material and bend and flex in response to electrical impulses—in other words, very much like biological muscle fibers.

The day when "bionic" men and women are seen strolling down the street with the help of such muscles is a long way off, but engineers at JPL who specialize in the emerging field have found a novel means to apply the technology for the first time.

The muscle technology will make its debut in a few years on board a palm-size NASA rover called MUSES.

The MUSES mission, scheduled for launch from Kagoshima, Japan, in January 2002, will send a rover to explore the surface of a small near-Earth asteroid, acquire a sample and return it to Earth.

The muscles will play a supporting role as miniature windshield wipers for the rover's infrared camera.

It is an unspectacular start, but JPL's Yosef Bar-Cohen, a physicist who is leading the muscle team, says that it nevertheless marks the entrance into legitimate usage of a technology that has long been only the subject of science fiction.

"Up until now, we were really way down the road" for applications, Bar-Cohen said.

Bar-Cohen recently convened the first conference for scientists and engineers interested in making artificial muscles a reality.

The meeting, held in Newport Beach in March, brought together more than 50 presenters from as far away as Sweden and Japan, and more than 100 engineers and scientists.

Between the conference and the muscles' space debut, Bar-Cohen hopes for a surge of interest and funding for artificial muscle research.

Scientists see a range of potential uses for the muscles, including repairing damaged muscles, giving robots additional dexterity and nimbleness, and bolstering the pumping of a weakened heart.

But for now, Bar-Cohen's primitive arm and hand integrate two different kinds of muscles and can lift only tiny pebbles.

The grasping "fingers" are actually polymer ribbons made of oxygen, fluorine and carbon chains.

When an electrical charge is applied to the ribbon, the charged particles in the plastic migrate from one side to another. The side of the film with more particles lengthens, while the other shortens—causing the ribbon to bend. Different frequency charges cause different displacements.

The film is covered with a special silicone-based coating that emulates the role human skin plays in protecting the electro-active processes of our muscles. Without it, the organic film would be exposed to the elements and rendered useless within minutes.

The second "muscle," which actually functions much more like a real muscle, consists of thin polymer sheets rolled into a long cylinder. Electrodes on both ends apply a positive and a negative charge, causing the wrapped sheet to contract toward the center. The constriction in turn forces the cylinder to expand lengthwise. When the current is cut off, the cylinder relaxes, lifting the load.

The wipers on MUSES will consist of two ribbons, made of electro-active material, that sweep back and forth across a one-inch-diameter lens, cleaning away asteroid dust.

The wipers' function is a crucial one, as dust could foil the mission. Dust buildup on solar panels was one of the reasons the 1996 Mars Pathfinder was eventually forced into retirement. Bar-Cohen's muscles provided an essential space- and weight-saving solution to MUSES engineers, who were searching for an alternative to clunky mechanical wipers.

Mechanical wipers were much too heavy, bulky, and energy-intensive for the diminutive nanorover, which weighs 1 kilogram.

At the conference's conclusion, Bar-Cohen issued a bold challenge for the future: an arm wrestling competition in 20 years between a bionic arm, made up completely of artificial muscle tissues, and a human arm, a la the much-publicized competitive series between Deep Blue, IBM's chess computer, and world chess champion Garry Kasparov.

Bar-Cohen hopes his challenge will galvanize scientists in the field to work toward a common goal.

"It can only happen if we work together," he said, explaining that many scientists with expertise on muscle-related technologies were working on different tracks.

The energetic Bar-Cohen is already looking beyond MUSES. He believes he is on to something by looking to biology for technological solutions: "The world out there," he says, "is a good model for us."